CLAIMS

1. Apparatus driven by high-frequency AC current source, for driving an electric load with low-frequency AC current, comprising:

a) a current splitting inductor, for generating, from said high-frequency current source, a first and a second high-frequency AC current sources;

b) a rectifier, coupled to said splitting inductor, consisting of rectifying diodes for rectifying said first and second high-frequency current sources, and capacitors, charged by said diodes, said capacitors being corresponding to a first and second DC current sources;

c) a controllable half-bridge commutator having a first and a second control inputs, said commutator being coupled to said DC current sources, for commutating said DC current sources, for allowing to generate, from said DC current sources, the low-frequency AC current required for driving said electric load; and

d) a control circuitry, having a first and a second outputs, said outputs being coupled to said first and second control inputs, respectively, and outputting two complimentary pulse trains, each of which having a frequency being automatically adjusted according to the operating conditions of said electric load, for controlling the switching time of said commutator, thereby causing said commutator to alternately change the direction of the current passing through said electric load.

2. Apparatus according to claim 1, in which the electric load is a High Intensity Discharge (HID) lamp, or an electric motor, the torque and rotating speed of

which are controlled by the magnitude of the low-frequency AC current and by the switching frequency of the commutator, respectively.

3. Apparatus according to claim 1, in which the rectifier is implemented by utilizing diodes in a full-bridge or half-bridge configuration.

4. Apparatus according to claim 1, in which the half-bridge commutator is implemented by utilizing a first and a second controllable switching means, said switching means being, whenever desired, alternately switched from conductive state to non-conductive state.

5. Apparatus according to claim 4, in which the first and second controllable switching means are transistors.

6. Apparatus according to claim 2, further including a resonant ignition circuit, for generating the voltage required for cold-ignition of the HID lamp, comprising:

a) a capacitance, being coupled in parallel to the HID lamp; and

b) an inductor, being connected in series with respect to the lamp, said inductor forming a serial resonant circuit with said capacitor, wherein the resonant frequency of said serial resonant circuit is selected to be higher than the operating frequency of the current passing through said HID lamp.

7. Apparatus according to claims 2 and 6, further including an ignition circuitry, for generating the high voltage required for hot-ignition of the HID lamp, comprising:

a) an autotransformer (Lr), one portion of which being connected in series with said resonant ignition circuitry, the inductor of which being the secondary side of a transformer and part of said resonant ignition circuitry, the primary side of which having a first end coupled to a first end of a capacitor;
b) a spark gap (SPRK), one end of which being coupled to a second end of said primary side, and a second end of which being coupled to a second end of said capacitor, said SPRK introduces a high impedance whenever the voltage across it is lower than a predetermined breakdown value, and a momentarily low impedance whenever the voltage across it exceeds said breakdown value; and
c) a rectifier, being fed by a second portion of said autotransformer, for allowing the energy, required for hot-ignition, to be stored in said capacitor, said energy being forwarded to said secondary side, whenever said SPRK introduces a low impedance, thereby allowing to obtain the voltage required for hot-ignition of said lamp.

8. Apparatus according to claim 7, in which the autotransformer is implemented by a transformer having first and second windings, being the first and second portions, respectively.

9. Apparatus according to claim 7, in which the rectifier is a voltage doubler.

10. Apparatus according to claims 2 and 7, wherein the operating condition is the cold, or hot, ignition phase, during which the frequency of the pulse trains is close to the resonance frequency of the Resonant Ignition

circuitry, or an intermediate phase, during which the frequency of the pulse trains gradually decreases, or the normal state, during which the frequency of the pulse trains is relatively low, and essentially constant.

11. Apparatus according to claim 1, wherein the current splitting inductor is implemented by an autotransformer, thereby allowing utilizing a relatively low AC voltage source.

12. Apparatus according to claim 1, wherein the current splitting inductor is implemented by a transformer, for allowing isolation between the signal source side and the load side.

13. Apparatus according to claim 1, in which the high-frequency AC current source is implemented by utilizing a high-frequency half-bridge inverter, being placed between a DC voltage source and the current splitting inductor, comprising:

a) a capacitor, a first contact of which being coupled to an input contact of the current splitting inductor, for blocking DC signals;

b) an inductor, a first contact of which being coupled to a second contact of said capacitor, for limiting the input current of said current splitting inductor; and

c) a third and a forth controllable switching means (Q11, Q12), being coupled to each other by their corresponding first contact, and to said DC voltage source by their corresponding second contact, said first contact being coupled to a second contact of said inductor, for allowing generating the high-frequency of said AC current source, said high-frequency being

essentially higher than a resonance frequency caused by said capacitor and said inductor, for allowing soft - switching said third and forth controllable sw itches.

14. Apparatus according to claim 1, in which the high-frequency AC current source is implemented by utilizing a Current-Sourcing Push-Pull Parallel Resonant Inverter (CS-PPRI), being placed between a DC voltage source and the current splitting inductor, comprising:

a) a transformer, the primary side of which having a first and a second input inductors, and the secondary side of which being the current splitting inductor;

b) a first Inductor (Lc), a first contact of which being coupled to a first contact of said first input inductor, and a second contact of which being coupled to a first contact of said second input inductor;

c) a resonant Capacitor (Cc), a first contact of which being coupled to a second contact of said first input inductor, and a second contact of which being coupled to a second contact of said second input inductor, said resonant capacitor, first Inductor (Lc) and input inductors forming a Parallel Resonant Circuitry (PRC), for allowing generating an alternating current source;

d) a second Inductor (Lin), a first contact of which could be connected to a DC power source and a second contact of which being connected to a middle contact of said first Inductor (Lc), the inductance of said second Inductor (Lin) being larger than the inductance of sai d first Inductor (Lc), for allowing said second Inductor (Lin) to generate the current required for driving said PRC;

e) a first controllable switch (Q12), a first contact of which being coupled to said first contact of said

capacitor, and a second contact of which being coupled to ground;

f) a second controllable switch (Q13), a first contact of which being coupled to said second contact of said capacitor, and a second contact of which being coupled to said ground; and

g) a Soft Switching Controller (SSC), for soft switching said second and third switches (Q12, Q13), the input of said SSC being fed with a signal representing the instantaneous magnitude of the signal at the second contact of said second Inductor (Lin), said SSC generates two complementary trains of digital signal, one of said trains being fed to an input terminal of said second switch (Q12) and the second train being fed to an input terminal of said third switch (Q13), for causing them to alternately switch from conductive to non-conductive state in synchronization with the instants at which said instantaneous magnitude reaches essentially a zero value, only one switch being in its conductive state at a given time.

15. Apparatus according to claim 1, in which the high-frequency AC current source is implemented by utilizing an input circuitry in a Flyback configuration, said circuitry being placed between a DC voltage source and the current splitting inductor, comprising:

a) a transformer, the primary side of which being an input inductor (L1), a first contact of which could be connected to a DC power source, and the secondary side of which being the current splitting inductor; and

b) a controllable switch (Q14), a first contact of which being coupled to a second contact of said input inductor (L1), and a second contact of which being

coupled to ground, said controllable switch (Q14) causes said input inductor (L1) to store energy whenever said controllable switch being in its conductive state , and to forward at least some of the stored energy to said current splitting inductor whenever said controllable switch is in its non-conductive state.

16. Apparatus according to claims 2 and any of claims 13, 14 or 15, further including a current feedback circuitry, for controlling the current passing through the HID lamp, comprising:

a) first and second windings of a current transformer, each of which being connected in series with the corresponding first and second high-frequency current sources, for sampling the current passing through the corresponding current source;

b) a rectifier, for generating a first signal being representative of the rectified sampled currents;

c) a first amplifier, having at least one reference input, being connected to a constant reference value, and a signal input, to which said first signal is forwarded, for generating an error signal representing of the deviation of said first signal from said reference value; and

d) a current mode PWM modulator, having a first input, to which said error signal is forwarded, a second input, to which a second signal, representing the current of the high-frequency AC current source, is fed, and at least one output, for outputting a corresponding train of pulses, the duty-cycle of which is a function of said error signal and of said second signal, and being connected to a corresponding driver, the output of which being coupled to the corresponding controllable switch,

for controlling its switching time, for causing the current passing through the HID lamp to be at the required value, thereby completing said feedback.

17. Apparatus according to claim 16, in which the PWM modulator is a voltage mode PWM controller, and the second input accepts a periodical ramp signal as a reference signal, the parameters of said periodical ramp signal being at least the cycle duration and ramp's slope and being determined so as to optimize the operation of said apparatus.

18. Apparatus according to claims 2 and 16, further including a voltage feedback circuitry, for allowing clamping the voltage across the HID lamp, whenever said lamp is in its off state, and increasing the current of said lamp during its warm-up period, comprising:

a) a sampling circuitry, for sampling a voltage representing the voltage across said lamp;

b) a second amplifier, having an input, to which the sampled voltage is forwarded, for generating a third signal, to be added to the first signal and being essentially zero whenever said lamp is in its ignition phase, for allowing to provide, to said lamp, a relatively increased current, while said lamp being in its warm-up stage and the voltage across it being relatively low, said third signal being essentially proportional to the voltage across said lamp while said lamp being in its normal operating state, for allowing to decrease said increased current to the required operating value; and

c) a third amplifier, having an input, to which the voltage representing the voltage across said lamp is

forwarded, for generating a fourth signal, said fourth signal being forwarded to the first amplifier and being essentially large whenever said lamp is in its 'off' state, or there is no lamp connected to the apparatus, for allowing to clamp the voltage on said lamp to a safe level, said fourth signal being essentially zero while said lamp being in its ignition phase or in its normal operating state, for allowing the lamp's current to reach the required operating value.